REMARKS

Pending Claims 17-30 and 32-66 stand rejected in the Final Office Action dated February 7, 2003. On entry of this Reply and Amendment, Claims 21 and 60 will be cancelled without prejudice. Accordingly, after entry of this Amendment, Claims 17-20, 22-30, 32-59 and 61-66 will be pending in this Application.

Claim Rejections over Shaffer/ASM Vol 9

Claims 33-39, 46-52 and 54-58 were rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,248,189 ("Shaffer") in view of the ASM Handbook vol. 9 Metallography and Microstructures ("ASM Vol 9"). The Office Action stated:

> Shaffer teaches a 6000 series (Table 1) cast (column 5 lines 10-11) aluminum alloy exhibiting: elongation =11%, UTS=59.3 ksi, YS=53.7 ksi (Table 3, example 3B).

The Office Action, however, acknowledged that Shaffer does not disclose that such alloy has a generally round grain structure. The Office Action attempted to remedy this deficiency by asserting that ASM Vol 9 in the micrograph in Fig. 192 on page 382 teaches a 6061-T6 extruded tube which "appears to have a 'generally round grain structure'" (quotes in the original). On this basis, the Office Action contended that one skilled in the art would expect the cast and wrought product taught by Shaffer to have the generally round grain structure recited in the present claims. Applicants respectfully traverse this rejection.

Shaffer, alone or in combination with ASM Vol 9 does not teach or suggest the combination of elements recited in independent Claim 33. Shaffer relates to an "aluminum alloy useful for driveshaft assemblies and method of manufacturing extruded tube of such alloy." The alloys of Table 3 of Shaffer were "hot extruded by die and mandrel method" (col. 5, lines 10-12), i.e., not simply cast but "hot worked" to achieve shape. Moreover, the alloy material was subsequently processed by methods including press quenching, cold drawing (40-50% total reduction), roll straightening and

artificially aging to achieve the physical properties shown in Table 3 and cited in the Office Action. As evidenced by the statements in the Declaration of Arvin Montes, one skilled in the art would expect an extruded aluminum alloy which has been processed in this manner to have an elongated grain structure, in contrast to the generally round grain structure produced by the present method.

It as been previously noted by Applicants that even the examples in Shaffer recognize the directionality of the grain structure of the aluminum alloy articles described. For example, Shaffer discloses that the grain sizes of the T8 temper aluminum alloys produced by a process that includes hot extrusion, cold reduction (40-50%), roll straightening, and artificial aging were measured. Shaffer recognizes the directional orientation of the tubing produced by this method and prescribes that the grain size is measured along the length of the article which is produced after extrusion.

The metallurgical art provides many examples that illustrate the production of an elongated grain structure in metal alloys produced by wrought working techniques. The ASTM method cited in Shaffer recognizes that cold working of aluminum alloys that results in light to moderate reduction (e.g., 40-50%) produces an elongated grain structure (see discussion below). In addition, Polmear, I J. "Light Alloys Metallurgy of the Light Metals" (Edward Arnold (Publishers) Ltd) contains a discussion of the effect of mechanical working on wrought aluminum alloys. At page 32, Polmear states that "[m]ost wrought products do not undergo bulk recrystalization during subsequent heat treatment so that the <u>elongated grain structure</u> resulting from mechanical working is retained. Three principal directions are recognized: longitudinal, transverse (or long transverse) and short transverse, and these are represented in Fig, 2.17" (emphasis added; Figure reproduced below showing the non-equiaxed grain structure). A copy of this excerpt from Polymear has been previously submitted with respect to this application.

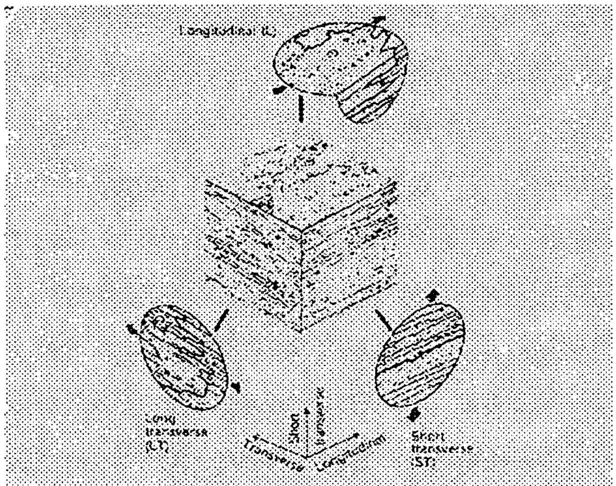

Fig. 2.17 The three principal directions with respect to the grain structure in a wrought aluminum alloy. Note the appearance of cracks that may form when stressing in these three directions (from Speidel, M. O. and Hyatt, M. V., *Advances in Corrosion Science and Technology*, Plenum Press, New York, 1972)

As noted in Dr. Montes' Declaration, the particular micrograph (Fig. 192) from ASM Vol 9 cited in the Office Action does not illustrate the formation of a generally round grain structure in a wrought worked aluminum alloy. The legend for Figure 192 expressly states that structure of the extruded tube is shown with the "extruded direction vertical." The elongation of the grains would occur along the direction of the extrusion. Figure 193 of the same reference shows a micrograph of an assembly that includes the extruded material shown in Figure 192. The microstructure of the extruded 6061-T6 tube clearly shows the elongated grain structure of the material depicted in Figure 192. In other words, the micrograph in Figure 192 shows the structure of a slice through the extruded tube that would not be expected to provide visualization of the elongation of the grain structure.

Dr. Montes Declaration also makes clear that the claim language, "generally roundgrain structure," would be understood by those skilled in the art to mean shperical or equiaxed grain structure, i.e., the claim language cannot be read upon the elongated grain structure of the prior art physically worked compositions.

As such, it is respectfully submitted that micrograph in Figure 192 of ASM Vol 9 does not suggest that the T8 temper alloys in Table 3 of Shaffer would have a generally round grain structure. Nor does ASM Vol 9 teach or suggest a 6000 series aluminum alloy having a generally round grain structure and the properties recited in Claim 33.

The Office Action admits that the Brinell Hardness recited in Claim 39 is not taught by Shaffer. In re Spada is cited by the Office Action for the proposition that "products of identical chemical composition can not have mutually exclusive properties" in an attempt to imply that the recited Brinnell Hardness value is an inherent property of the alloy described in Shaffer. While this may be true of some chemical compositions, it is well known to those of skill in the metallurgical art that physical properties are not directly correlated with the chemical composition of metal alloys. In general, the properties of metal alloys are highly dependent on the processing operations to which they have been subjected. The example in Shaffer cited by the Office Action provides a graphic illustration of this fact. The values reported in Table 3 for ultimate tensile strength, % elongation and yield strength vary dramatically for alloys with the same chemical composition depending on the processing conditions used to produce the tubing (e.g., T1 vs. T8 temper; water quenched extrusion vs. air quenched extrusion).

In view of the above remarks, it is respectfully submitted that Claims 33-39, 46-52 and 54-58 are not obvious in view of Shaffer, alone or in combination with ASM Vol 9.

Claim Rejections over Kroger

Claims 17-18, 20, 25, 30, 32 and 40-45 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 3,791,876 ("Kroger").

Kroger shows a "high strength aluminum alloy" that is purported to be "substantially free from porosity as revealed by a dye-penetrant examination" (col. 1 lines 65-68), which appears to result from "an extensive working operation" such as extrusion, forging or rolling. (See col. 2, line 65 to col. 3, line 5: "Regardless of the particular working operation employed to produce the forging stock it is important that

the working be rather extensive or severe"; see also col. 5, lines 65-68: "Forgings produced in accordance with the improved method exhibit marked strength improvements over ordinary 7075 Forgings."). An elongated grain structure associated with such worked material would be expected. (See discussion above regarding Shaffer).

As explained in Dr. Montes' Declaration, the presently claimed centrifugally cast alloys differ from Kroger's extruded and forged 7075 in a number of ways.

1. The grain structure of Kroger's wrought product is not equiaxed based on the anisotropic mechanical properties shown in Table 1 (Columns 5 and 6, Lines 33-44).

2. The present centrifugally cast alloys, as well as other centrifugally cast grades of aluminum, do not undergo recrystallization, but produce an equiaxed grain structure. Further evidence of an equiaxed grain structure is the isotropic properties that the materials exhibit.

3. Fatigue properties of the centrifugally cast 7075-T6 aluminum are superior to those of wrought 7075-T6 below an alternating stress of 30 ksi. The difference in fatigue properties is related to the elongated structure of closed pores and second phase particles in the wrought 7075 aluminum. These elongated structures act as stress risers and initiation points for fatigue cracks.

Claim Rejections over Zhou

Claims 17-21, 23-24, 27-28, 32 and 40-45 were rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,120,625 ("Zhou"), a single reference.

Zhou relates to a "processes for producing fine grained metal compositions using continuous extrusion for semi-solid forming of shaped articles." Zhou shows an extrudate that emerges from an extrusion die, which is then "heated to a temperature between the solidus and liquidus temperatures of the metal to provide a microstructure which consists of discrete spheroidal particles" suspended in a "lower melting liquid matrix" and "converted into a semi-solid structure" (col. 3 lines 23-29, emphasis added). Figure 3B of Zhou shows the microstructure of a continuously extruded alloy

after being heated to a semi-solid temperature. The "discrete spheroidal particles" of Figure 3B appear to be separated by the lower melting matrix. There is no showing that the extruded alloy described in Zhou would have the combination of physical properties recited in the present independent claims.

As explained in Dr. Montes' Declaration, the presence of lower melting point constituents can have a profound affect on both mechanical and corrosion properties. Dr. Montes also states that Zhou's semi-solidly formed 6061 material is significantly different from aluminum alloy materials produced by the present method.

1. Zhou's material contains macrosegregation into aluminum-rich particles and a continuous low-melting point matrix. In comparison, the microstructure of the centrifugally cast aluminum produced by the present method contains only a minor amount of discrete isolated second phase particles, i.e., a substantially uniform microstructure.
2. The chemical composition of Zhou's low-melting point matrix is distinctly different from the aluminum-rich particles. This difference can decrease tensile properties, fatigue properties, fracture toughness properties, and corrosion properties.

Moreover, Dr. Montes points out that Zhou has not reported any specific mechanical or corrosion properties for the materials disclosed. Based on the time-temperature profile of Zhou's process and the reported microstructure, however, the material can be assumed to be in the annealed condition. As a result of Zhou heating the material to a temperature significantly higher than the recrystallization temperature, T_R, all mechanical properties associated with the T4 temper would be removed.

The compositions of Zhou are not encompssed within the present claims by virtue of, inter alia, the transitional language "consisting essentially of." Therefore, the rejection based on Zhou should be withdrawn.

Other Claim Rejections

Claims 17-18, 32 and 40-45 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,520,754 ("Yaney"). Claims 17-18, 20, 22, 29,

32 and 40-45 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,032,359 ("Pickens et al.").

As Applicants have previously noted, the Examiner has acknowledged that neither Yaney et al. nor Pickens et al. "teach (a) a process of producing said aluminum alloy by centrifugally casting and then hot isostatically processing (instant independent Claim 17)." However, the Examiner stated that "it is well settled that a product-by-process claim defines a product, and that when the prior art discloses a product substantially the same as that being claimed, differing only in the manner by which it is made, the burden falls to applicant to show that any process steps associated therewith result in a product materially different from that disclosed in the prior art." The Examiner concluded that the references each (individually) teach an aluminum alloy product that is substantially the same as the presently claimed alloys and render obviousness of the presented claimed invention.

Yaney et al. relates to a "spray cast Al-Li alloy composition and method of processing." The Final Office Action acknowledges that Yaney does not teach the present process. Nor does Yaney teach the presently claimed materials. The Final Office Action contains a reference to Figure 4(c) as supporting a material having an elongation of 8%. Applicants note that Yaney's description of Figure 4(c) specifically states that this graph depicts the ductility of a material "which has undergone thermomechanical processing of the type required for fabrication into structural components for aerospace applications," i.e., the material would be expected to exhibit an elongated grain structure (see column 5, lines 32-43). Table 2 of Yaney et al. also shows a number of properties of Al-Li alloy materials. These Al-Li alloy compositions, however, are the result of material that has undergone "metal working steps" including "forging" and "rolling" (col. 8 lines 20-35). An elongated grain structure associated with such worked material would be expected. Thus, Yaney et al. does not disclose an unworked alloy having properties that satisfy the definitions set forth in the present claims.

Pickens et al. shows an aluminum-lithium alloy that was "cast, homogenized, extruded, solutionized, quenched, and stretched (col. 5, lines 45-49, emphasis added,

and Table III). An elongated grain structure associated with such extruded material would be expected.

Applicants respectfully submit that none of the teachings of Kroger, Yaney et al., Zhou et al. or Pickens et al. would not suggest the subject matter recited in present independent Claims. Kroger, Yaney et al., Zhou et al. and Pickens et al., alone or in any proper combination, do not disclose, teach or suggest the presently claimed aluminum alloys. For the reasons discussed above, the subject matter recited in the pending claims, considered as a whole, would not have been obvious to a person having ordinary skill in the art based on the references cited in the Office Action. Therefore, it is respectfully requested that the rejections over Kroger, Yaney et al., Zhou et al. and/or Pickens et al be withdrawn.

Claim Rejections over ASM Handbook Vol 9

Claims 59 and 61-66 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over ASM Handbook Vol 9. As with the discussion of Figure 192 from ASM Handbook Vol 9, Applicants submit that the reference to a micrograph of a single orientation of an alloy material is insufficient to establish that the material has a generally round (i.e., equiaxed) grain structure. In order to determine if the grain structure of a material is equiaxed, microstructures of the material must be viewed in more than one orientation or direction (see discussion in Dr. Montes' Declaration regarding the expected grain structure of wrought worked materials and, in particular, wrought worked 7075 alloys). Accordingly, it is respectfully submitted that claims 59 and 61-66 are not obvious in view of ASM Handbook Vol 9, either alone or in combination with the "Metals Handbook: Desk Edition." Withdrawal of the rejection is respectfully requested.

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The Examiner is invited to telephone the undersigned if such would advance the prosecution of the Application.

Respectfully submitted,

Date July 7, 2003

By [signature]

Charles G. Carter
Attorney for Applicant(s)
Registration No. 35,093

FOLEY & LARDNER
Customer Number: 26371

26371
PATENT TRADEMARK OFFICE
Telephone: (414) 297-5842
Facsimile: (414) 297-4900